Decision making into local planning
NOAA SARP webinar, January 15, 2014

Community Stormwater Response to a Changing Landscape and Climate:

Willems et al., 2012

"…Need more studies to evaluate the climate change – infrastructure response at the urban watershed/pipe-scale"

SYNTECTIC INTERNATIONAL

STRATUS CONSULTING

ANTIOCH UNIVERSITY NEW ENGLAND

MINNEHAHA CREEK WATERSHED DISTRICT

UNIVERSITY OF MINNESOTA

Minneapolis City of Lakes

VICTORIA City of Lakes & Parks

Goals of stakeholder participation

Improve:

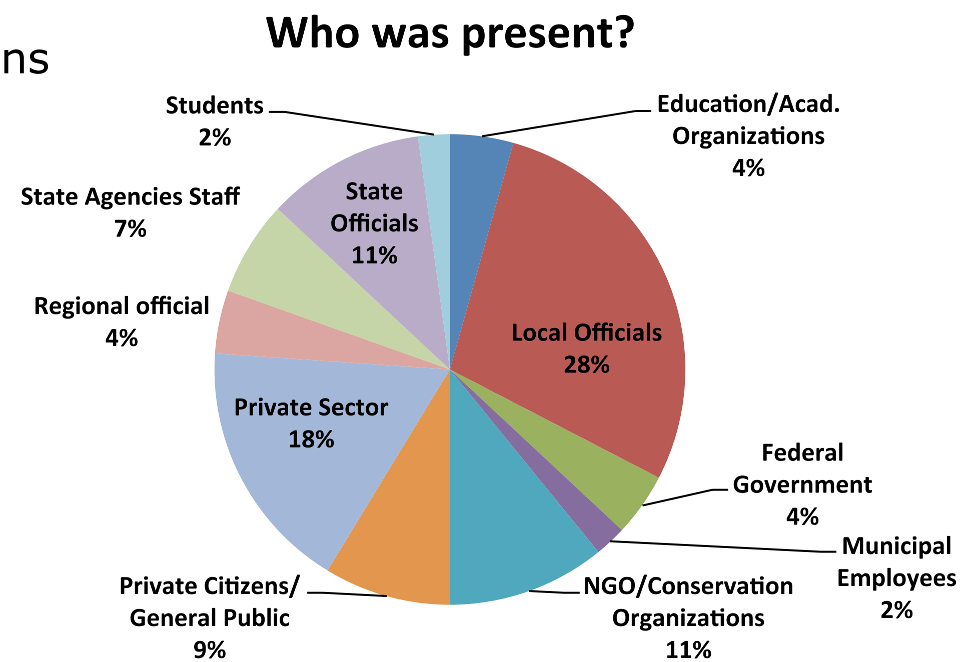
- Quality
- Legitimacy
- Capacity of environmental assessment and decisions

Convene community leaders and a broad list of stakeholders

Benchmarks for Success, & Key Inputs… → …Convening… → …To Achieve desired Outcomes

•Convened a broad cross-section of stakeholders that included representatives of:

- Education/Academic Organizations
- Local Officials
- Federal Government
- Municipal Employees
- NGO/Conservation Orgs.
- Private Citizens/ Public
- Regional official
- State Agencies Staff
- State Officials
- Students



•Input Example: Clear Ground-Rules
with all sessions open to the media/public…high transparency

Data Input

Historical Climatic Data
Precipitation
Evapotranspiration

Precipitation Scenarios
Global Circulation Models
Down-Scaling

Current Land Characteristics
Soils,
Water Bodies
Parks /Protected Land

Projected Land Characteristics
Impervious Surfaces
Green Infrastructure

Pipe Configuration
Minneapolis (Hiawatha basin)
Victoria

Modeling

Run-off / Peak Flow Calculations
EPA-SWMM
Calibrated 2005

Outputs

Projected Precipitation Amounts
Optimistic - Pessimistic

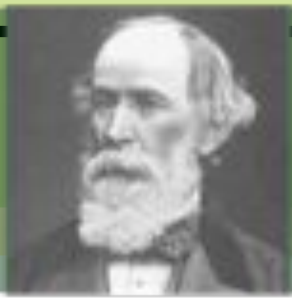
System Components Adequacy
Current
Projected

Projected Pipe Sizing

Impact of Green Infrastructure
Extent of Mitigation

Projected Cost Impacts

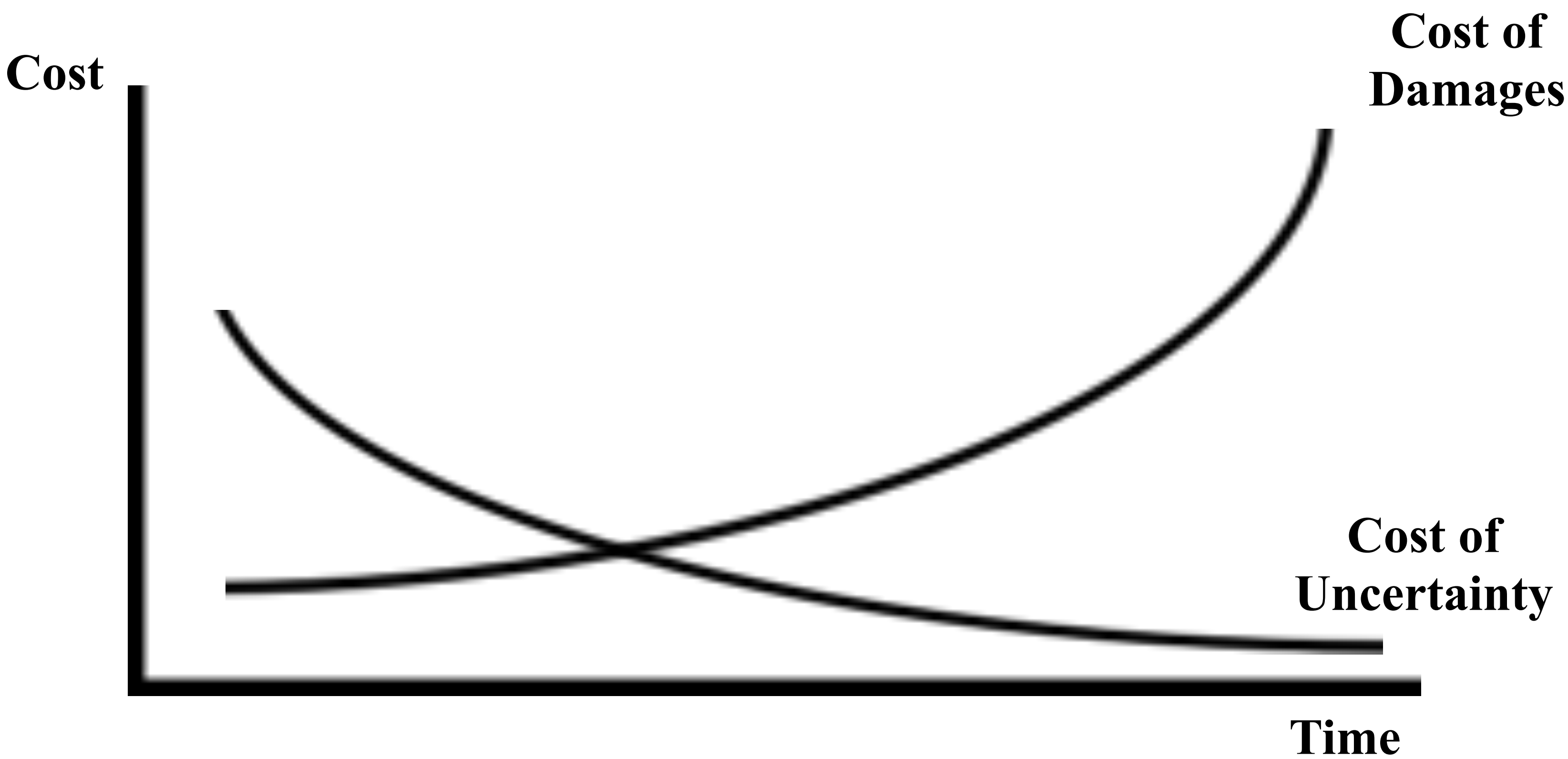
Risk & Uncertainty



Thomas Mulvaney & Svante Arrhenius

	Rainfall/Runoff Modeling	Adaptation of stormwater systems
Original formulation	Mulvaney, 1851	Arrhenius, 1896
Theory development 70-80 yrs later	Green-Ampt, Sherman, Yarnell	1st, 2nd gen. General Circulation Models
State of the art today	Sophisticated models, but uncertainty persists	Sophisticated models, but uncertainty persists
Design based thereon?	Yes, to best-available knowledge, with safety margin	No

Adapt now or wait?

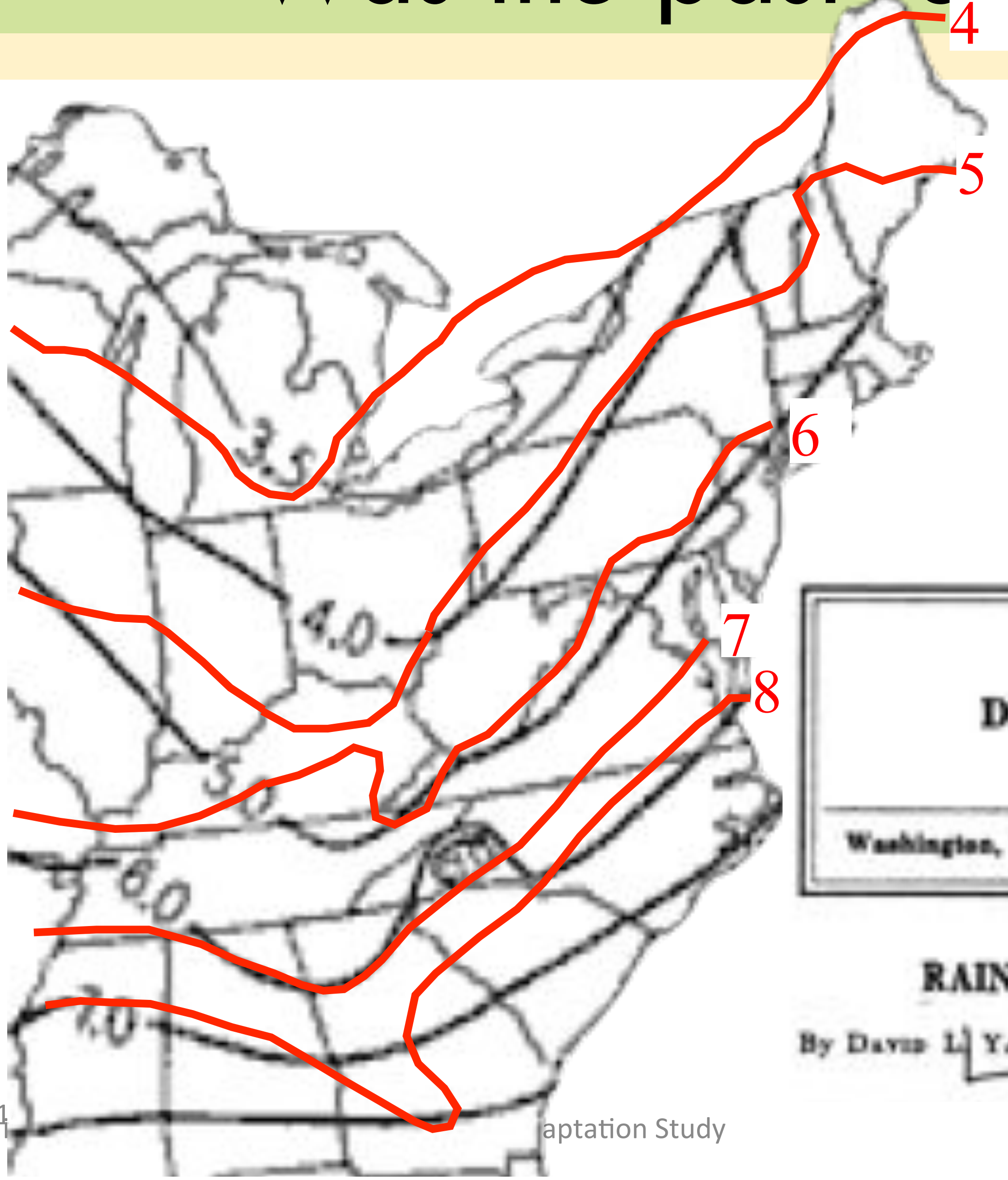


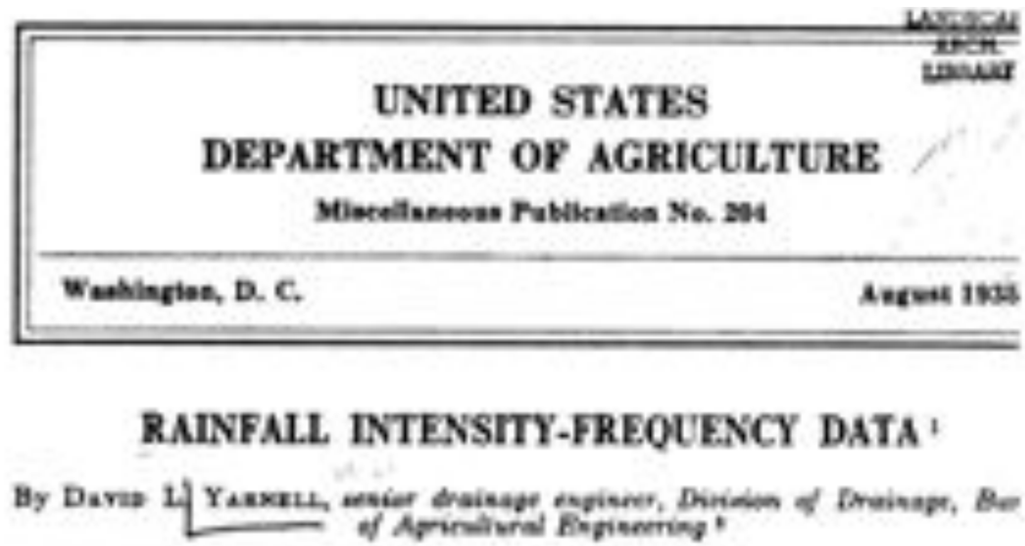
Was the past *really* certain?

- "...too little data is available on the factors influencing the rainfall-runoff relationship to expect exact solutions."
  MN DoT Drainage manual, 2000

- **"...**Recognizing the high degree of error or uncertainty inherent in many aspects of stormwater modeling...Generally, the goal of stormwater modeling is to provide a reasonable prediction of the way a system will respond to a given set of conditions. **"**
  MN Stormwater Manual, 2006

Was the past *really* certain?





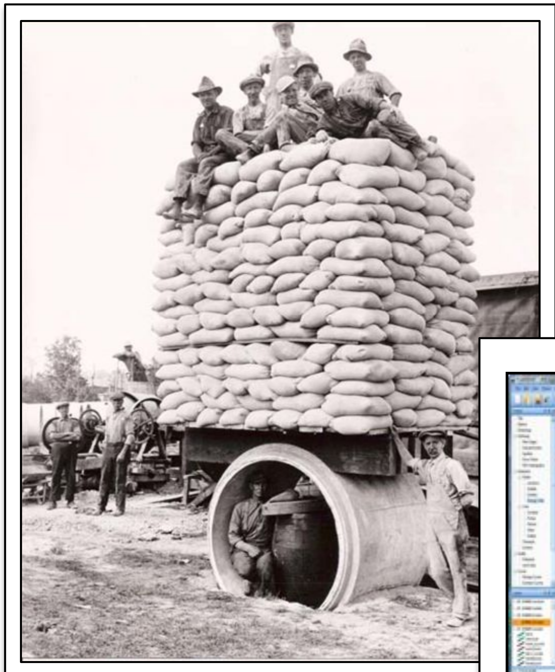
UNITED STATES
DEPARTMENT OF AGRICULTURE
Miscellaneous Publication No. 204

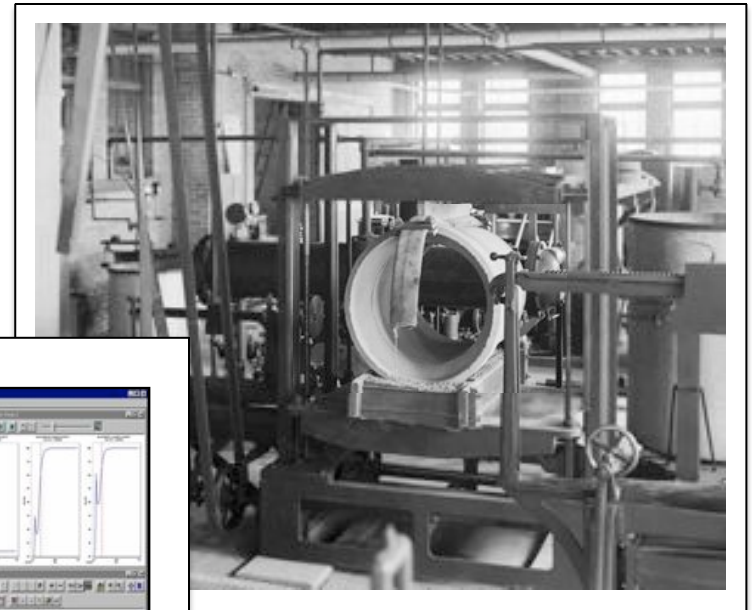
Washington, D. C. August 1935

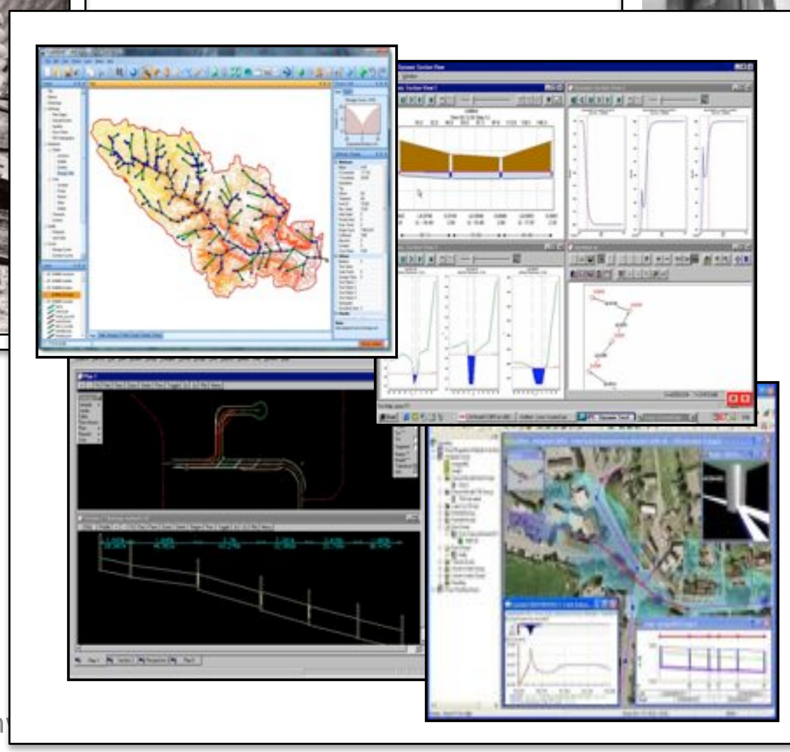
RAINFALL INTENSITY-FREQUENCY DATA[1]

By DAVID L. YARNELL, *senior drainage engineer, Division of Drainage, Bureau of Agricultural Engineering*[2]

Design methods change…

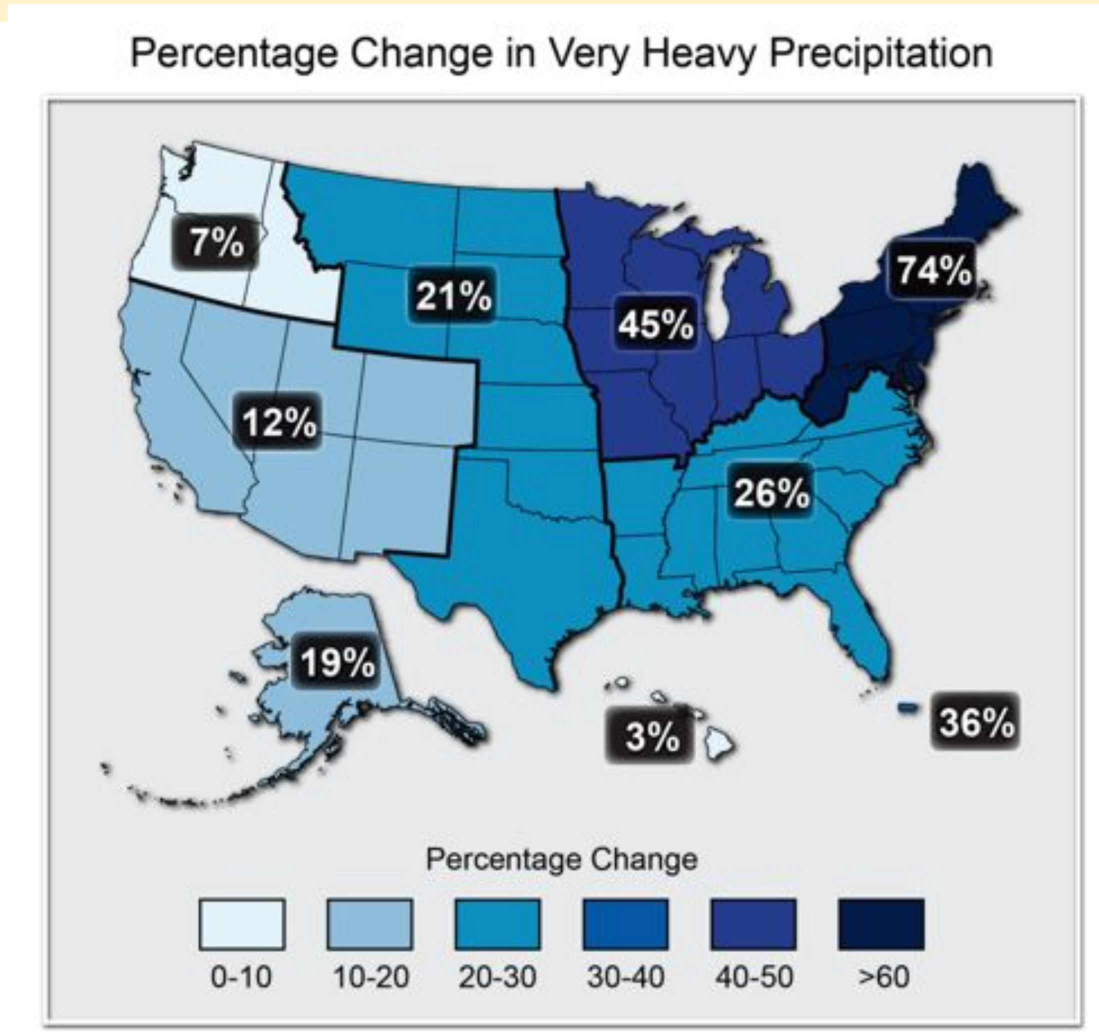






Was the past *really* stationary?

- **Very heavy precipitation (heaviest of 1% of all events)**
- **Percentage increase in from 1958-2007**



NCADAC, 2013

Cli-Chg can inform design specs

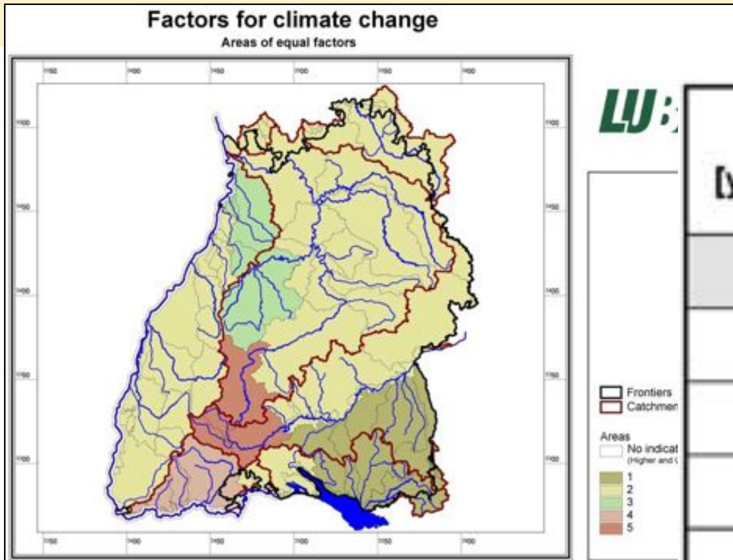


Fig. 8: Areas in Baden-Württemberg with uniform climate change factors $f_{T,K}$

T [years]	Factors for climate change $f_{T,K}$				
	1	2	3	4	5
2	1,25	1,50	1,75	1,50	1,75
5	1,24	1,45	1,65	1,45	1,67
10	1,23	1,40	1,55	1,43	1,60
20	1,21	1,33	1,42	1,40	1,50
50	1,18	1,23	1,25	1,31	1,35
100	1,15	1,15	1,15	1,25	1,25
200	1,12	1,08	1,07	1,18	1,15
500	1,06	1,03	1,00	1,08	1,05
1000	1,00	1,00	1,00	1,00	1,00

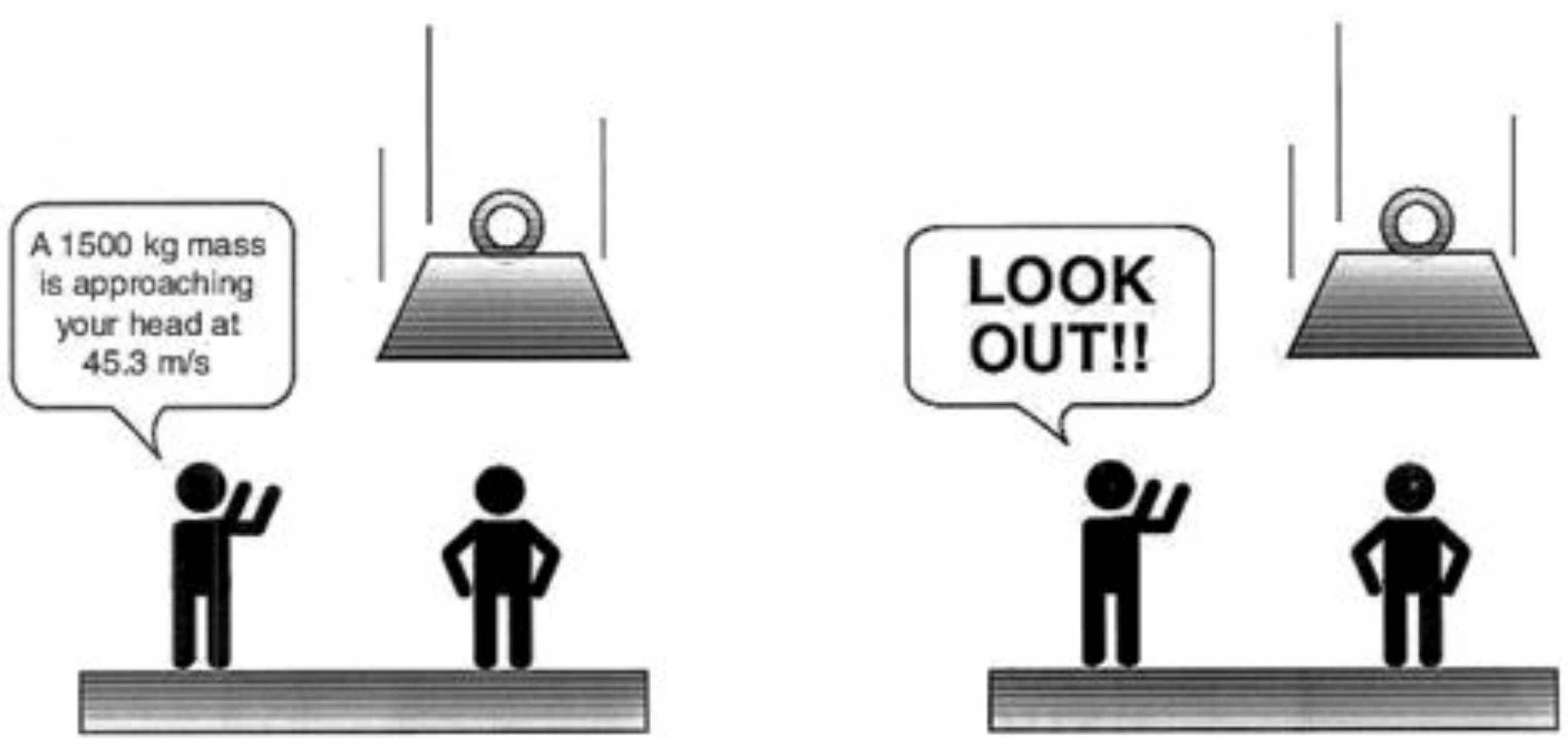
Remark: Factor is equal 1.0 for annualities T>1000a

Fig. 9: Climate change factors $f_{T,K}$ to determine the design flood for the areas c river catchments in Baden-Württemberg

Hennegriff et al. 2006

Risk & Uncertainty

Researchers vs. practitioners

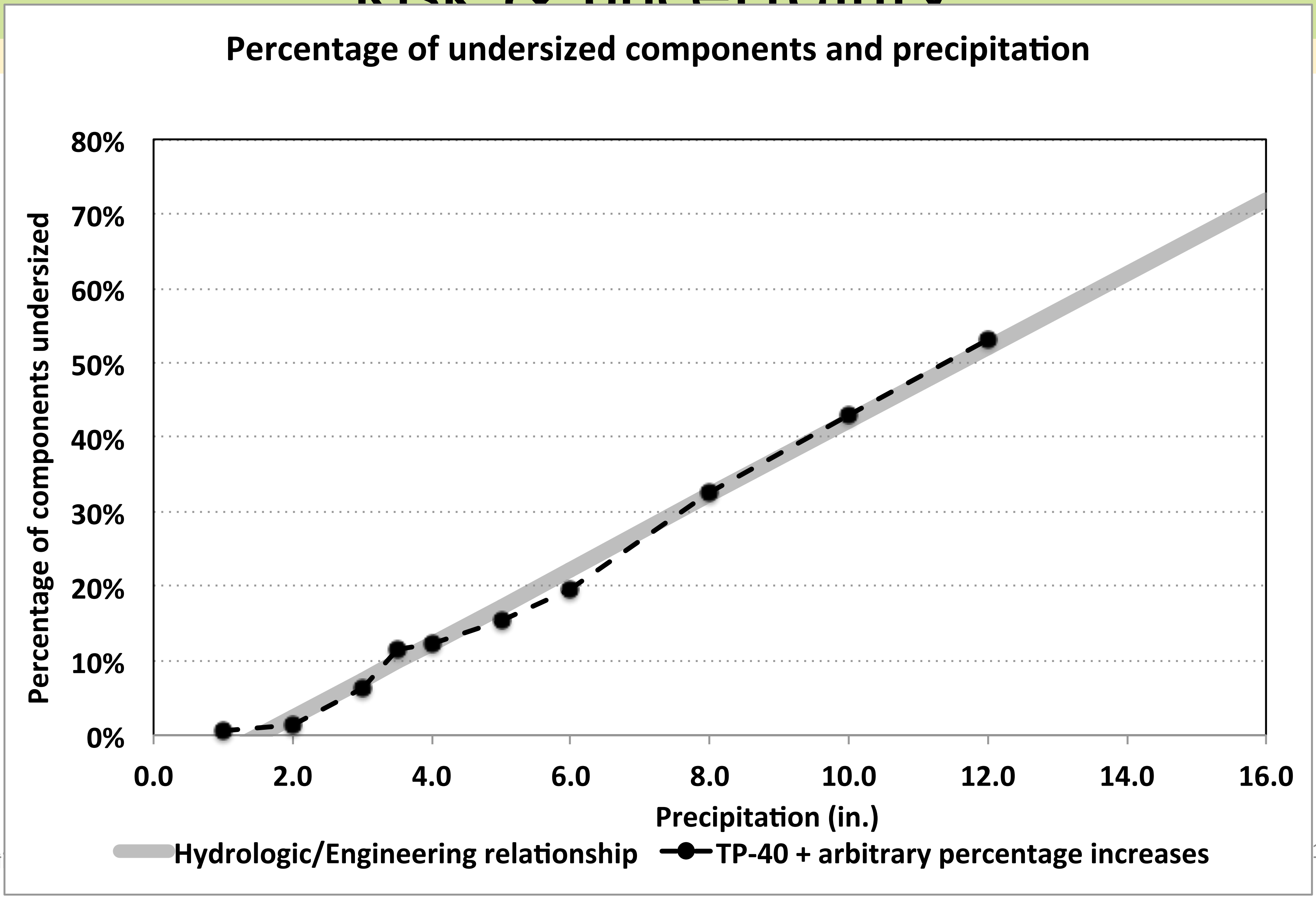


The Mathworks Inc. Fuzzy Logic Toolbox User's Guide. P. 1-7
http://www.mathworks.com/help/pdf_doc/fuzzy/fuzzy.pdf

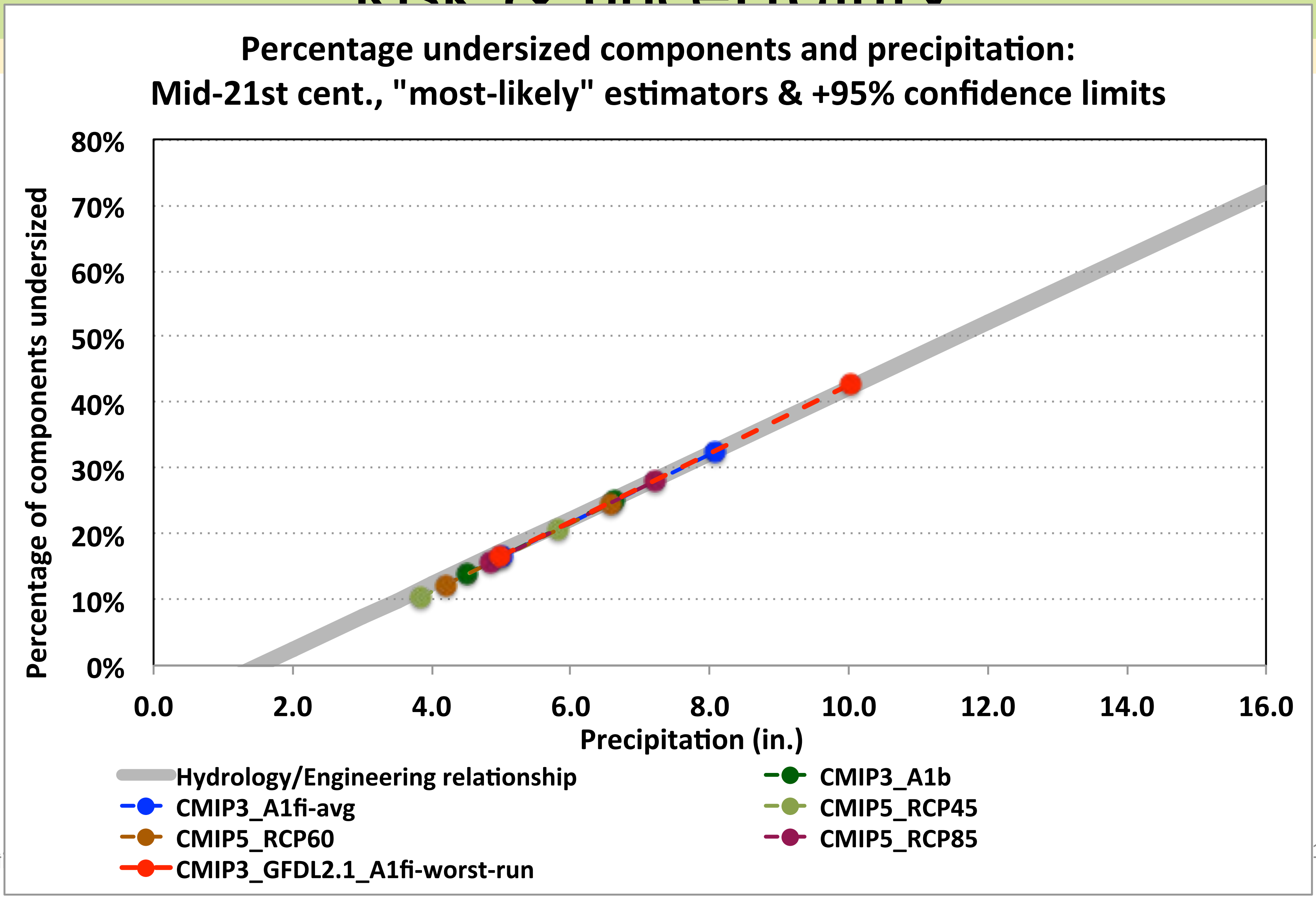
Climate modeling results: Current and Future

Return period (years)	Recent climate	mid-21st cent. Optimistic	mid-21st cent. Moderate	mid-21st cent. Pessimistic
2.5	2.5	2.84	3.3	6.86
5	3.17	3.47	4.11	8.4
7.5	3.57	3.88	4.66	9.39
"Design Storm" 10	3.86	4.19	6.56	10.13
25	4.84	5.28	6.74	12.75
50	5.67	6.22	8.31	15.03
75	6.2	6.82	9.39	16.5
100	6.59	7.27	10.23	17.59

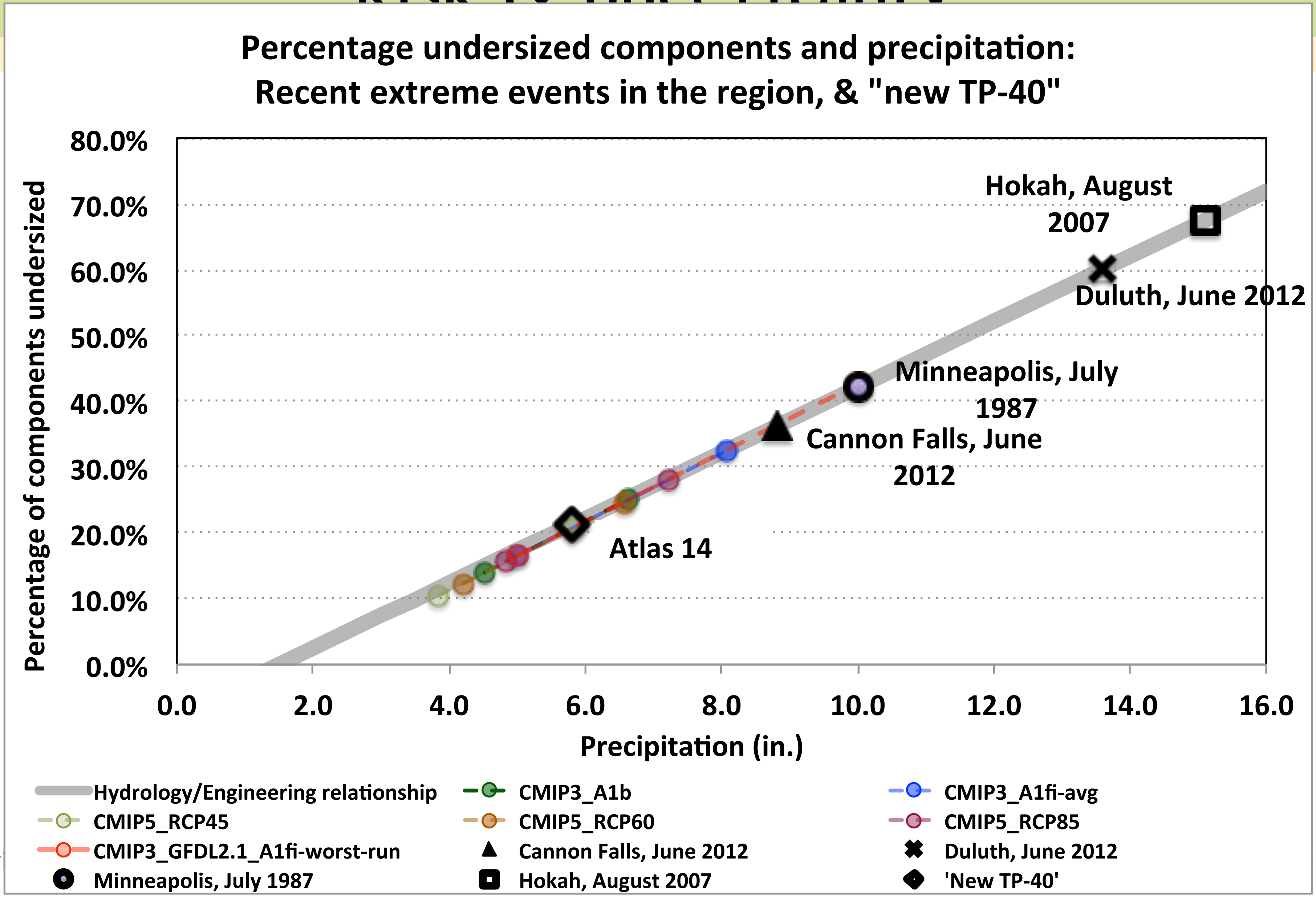
Risk & uncertainty



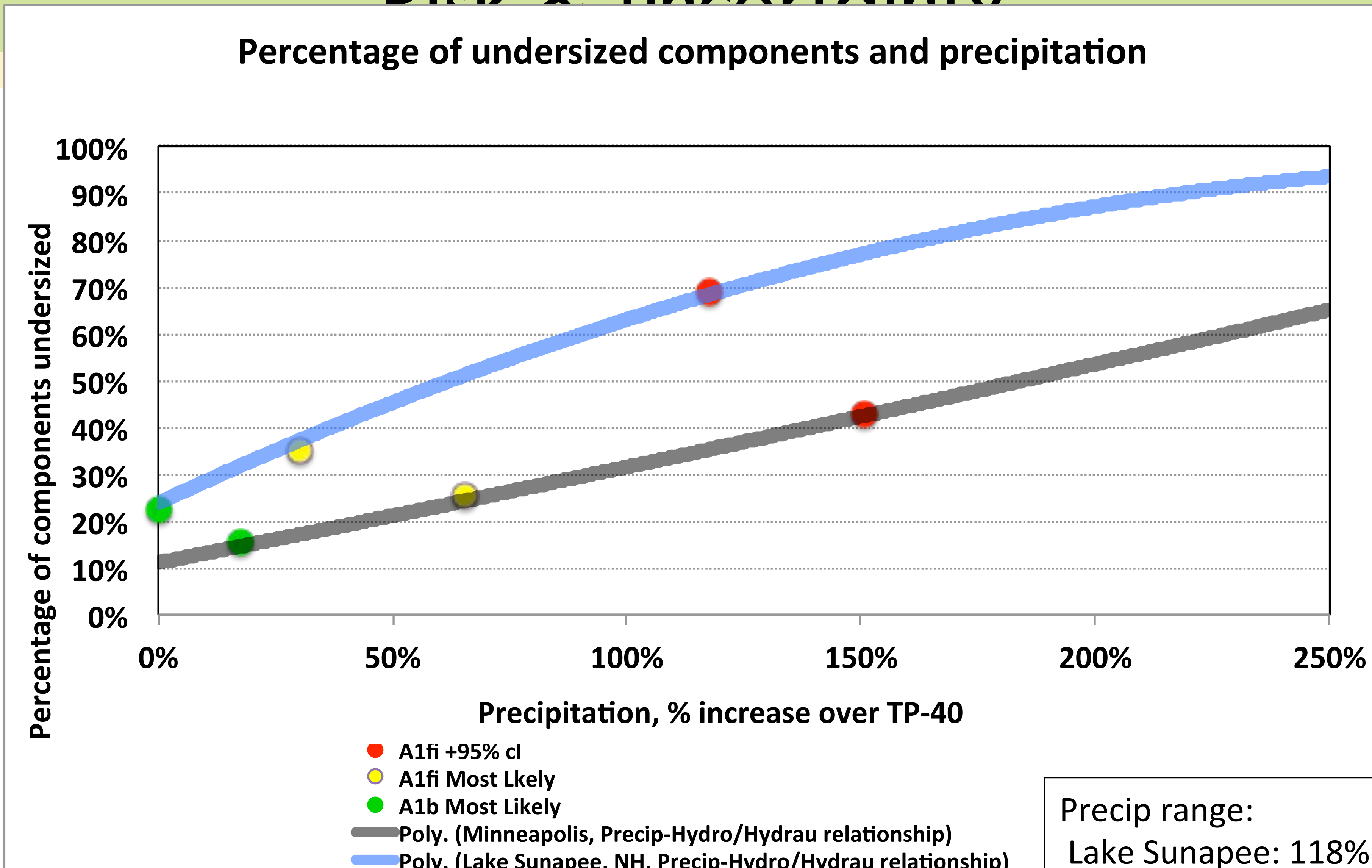
Risk & uncertainty



Risk & uncertainty



Risk & uncertainty



Precip range:
Lake Sunapee: 118%
Minneapolis: 157%

- Minneapolis hydrologic model calibration study, used since 2004 to design the City's stormwater systems

Peak flow (Qp), actual from flow-gauge vs. XPSWMM model			
		Actual vs calibrated model	Actual vs uncalibrated
Site	Calibration storm (in.)	Runoff	Runoff
22nd_&_Aldrich	2.20	-38%	1%
22nd_&_Aldrich	2.05	-41%	-11%
14th_&_park	2.20	50%	50%
14th_&_park	2.05	38%	38%
Parade Stadium	2.20	-72%	-98%
Parade Stadium	2.05	-15%	-81%
61st and Lyndale	2.20	71%	108%
61st and Lyndale	2.05	189%	216%
58th and Portland	2.20	75%	172%
58th and Portland	2.05	24%	24%
mean		28.3%	41.9%
range		261.2%	313.9%
std_dev		75.7%	100.7%

Risk & Uncertainty

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Paralysis by Analysis Should Not Delay Decisions On Climate Change, Experts Urge

Nov. 27, 2012 — Uncertainty about how much the climate is changing is not a reason to delay preparing for the harmful impacts of climate change, says Professor Jim Hall of the Environmental Change Institute at the University of Oxford and colleagues at the Tyndall Centre for Climate Change Research, writing in *Nature Climate Change*.

Share This:

The costs of adapting to climate change, sea-level and flooding include the upfront expenses of upgrading infrastructure, installing early-warning systems, and effective organisations, as well as the costs of reducing risk,

Related Topics

Earth & Climate

- Climate
- Global Warming
- Environmental Issues

Science & Society

- Environmental Policies
- Resource Shortage
- Ocean Policy

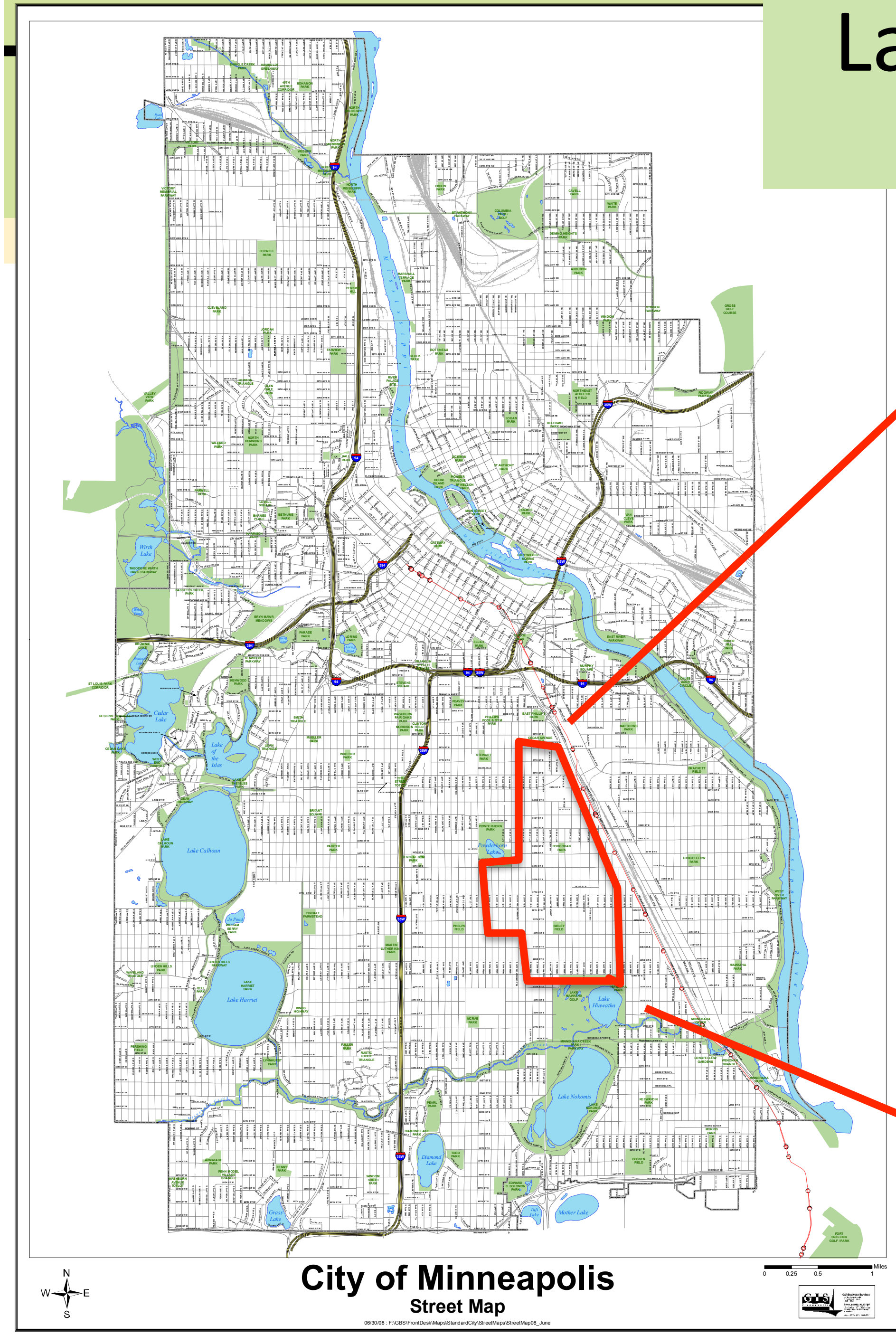
Articles

- Consensus of scientists regarding global warming
- Scientific opinion on climate change
- Instrumental temperature record
- Climate model
- Climate
- Environmental impact assessment

Hiawatha :
System Flood Volumes

Precip. Scenario (in)	Flood Volume (MG)		
	Total	Street Storage	Over-curb
3.93	2.46	1.61	0.86
4.15	2.92	1.80	1.12
4.77	3.95	2.30	1.66
5.66	5.82	3.07	2.75
6.56	10.05	3.70	6.34
8.07	20.02	5.41	14.61
10.1	40.05	5.94	34.11

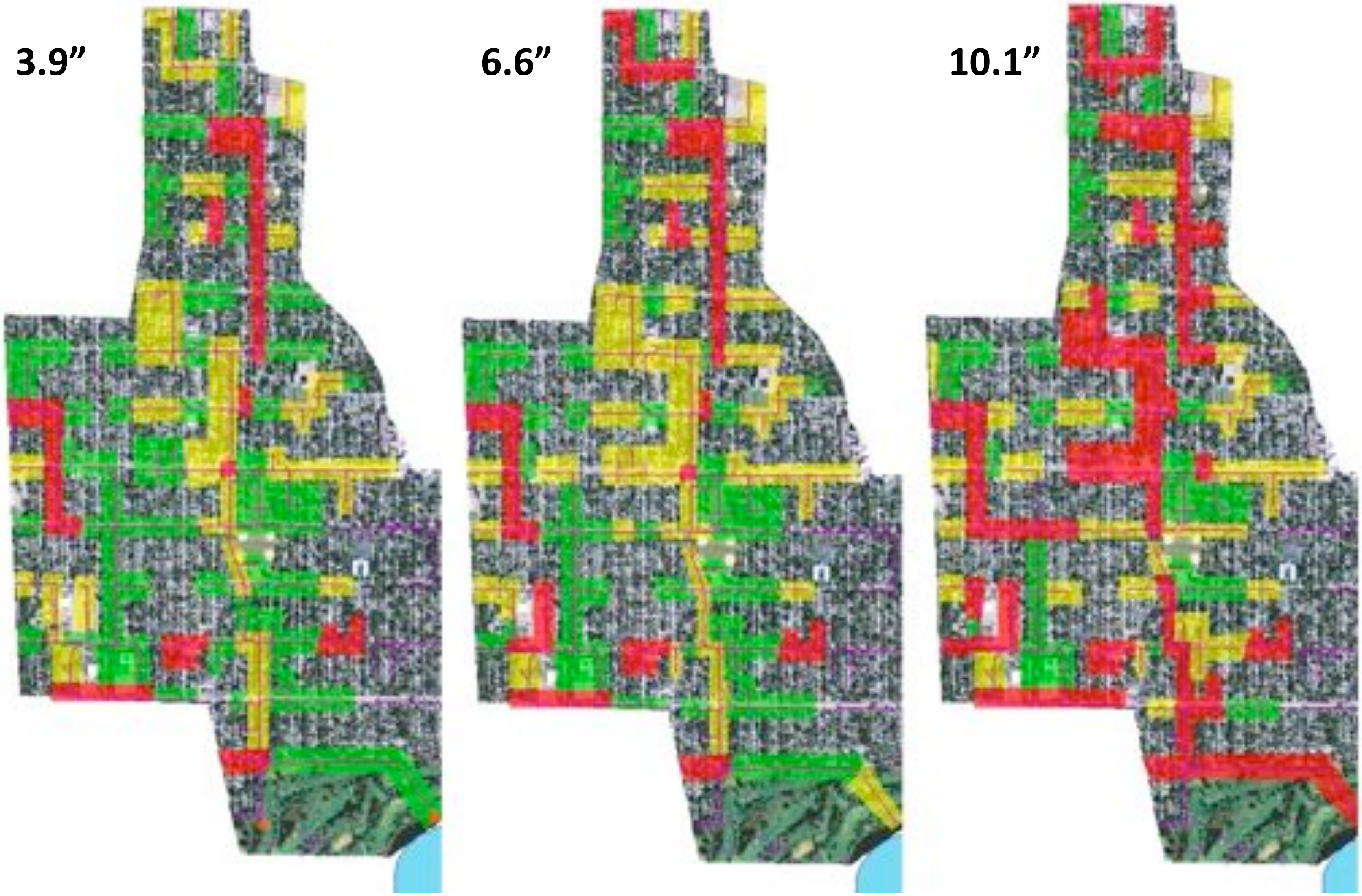
Lake Hiawatha pipeshed, Minneapolis, MN



3.18-in Storm

Pipe Capacity
Adequate
Undersized

Recent Storms **Moderate Projection** **Pessimistic Projection**



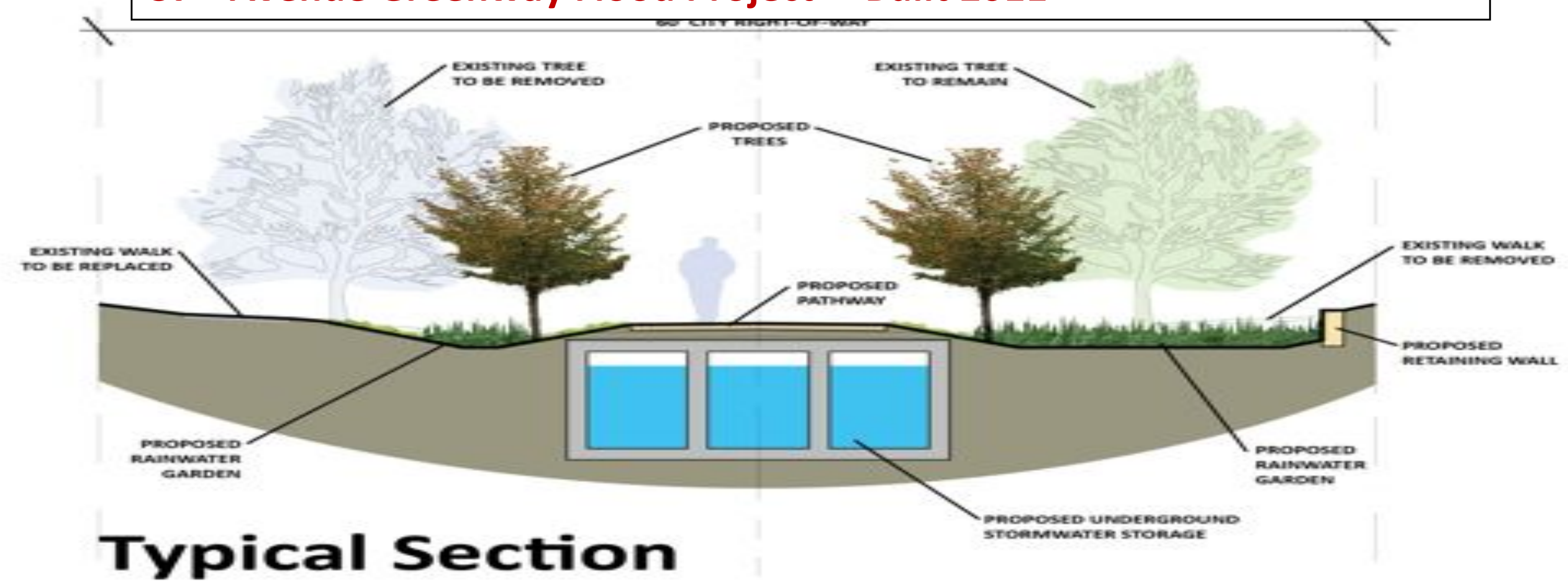
City of Minneapolis – Lake Hiawatha Pipe-shed

1

Bancroft Meadows Flood Basin **Built 1989**

(Bloomington and 42nd)

37th Avenue Greenway Flood Project   Built 2011

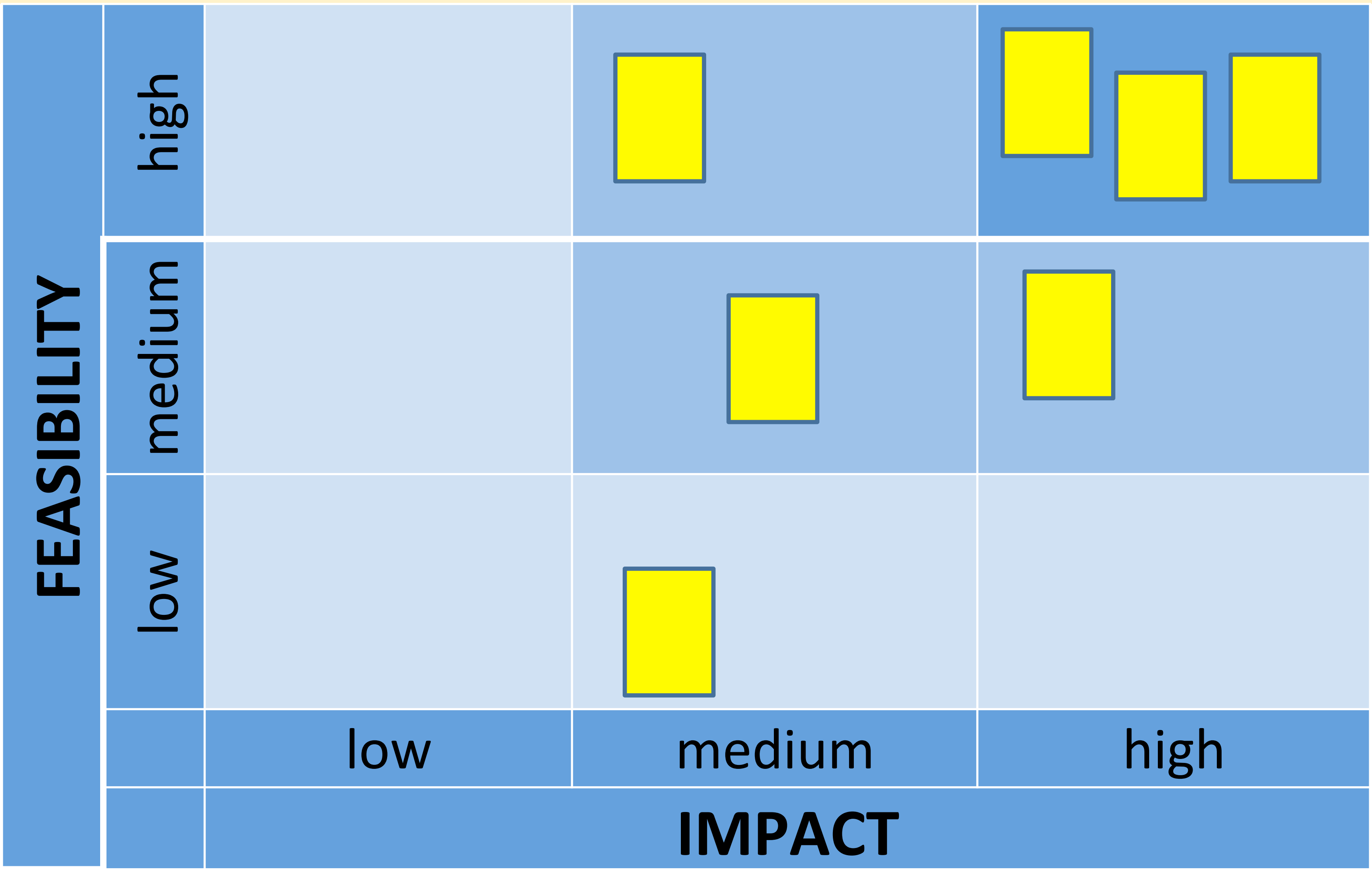


Costs for Adaptation – City of Mpls (Prelim.)

10-yr Event	Flood Volume (over curb)	Increase Undersized Pipes to Eliminate Over- Curb Flooding		Dry Basin Storage	Under-ground Storage	50% LID - Impact on Peak Flow*
	MG	Ft of Pipe	Cost	Cost	Cost	% Red
3.9”	2.92	3,439	$6.5M	$0	$0	-39%
6.6”	6.34	20,405	$38.8M	$151K	$9.8M	-38%
10.1”	34.11	---	---	$715K	$46.5M	-28%

*LID does not provide effective flood control during large storm events

Impact Vs. Feasibility Grid



Adaptation options & costs

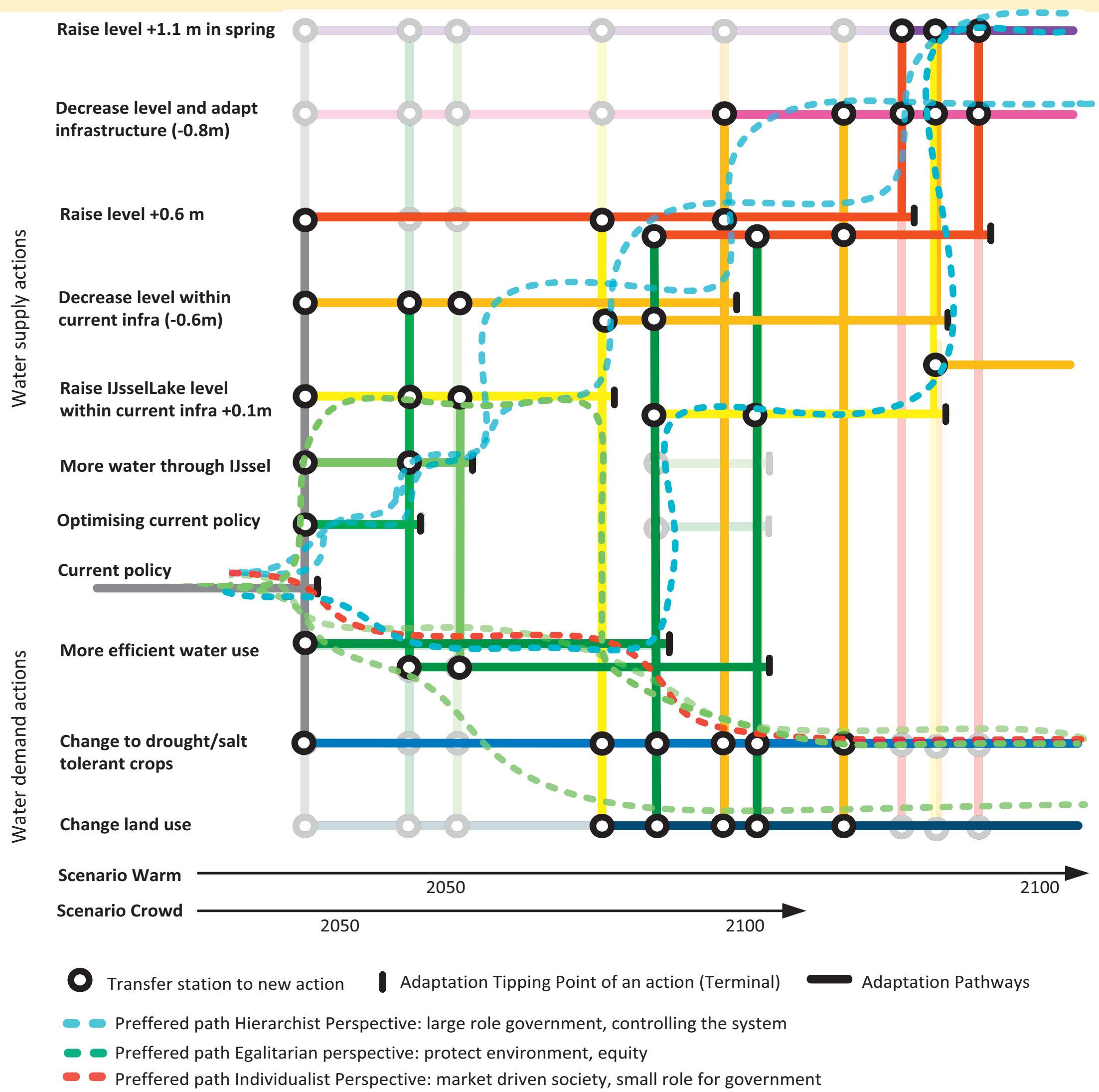


Fig. 7. Adaptation pathways map with preferred pathways for three different perspectives.

Hasnoot et al., 2013

Let’s adapt our forebears’ common sense

You can cut

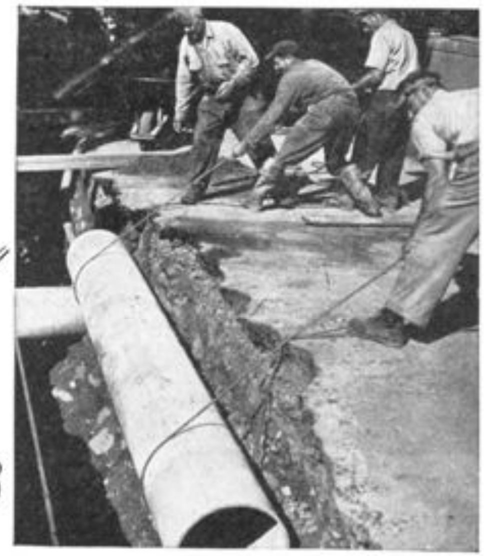
installation costs

... lay

pipe faster...

speed completion

of entire job...



Citations

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Hennegriff W, Kolokotronis V, Weber H, Bartels H. 2006. *A - Abwasser Abfall (Sewer Waste)* 53:8, 1

The Mathworks Inc. Fuzzy Logic Toolbox User's Guide. P. 1-7 http://www.mathworks.com/help/pdf_doc/fuzzy/fuzzy.pdf

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